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IOT Enabled LoRA based Industrial Automation

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Abstract **- The LoRa-based Industrial Automation system is designed to automate load control in industrial and home automation applications using a Node MCU, an MQ135 sensor, a DHT11 sensor, and a relay. The system consists of a Node MCU board, a LoRa module, an MQ135 sensor, a DHT11 sensor, and a relay module. The Node MCU is programmed to read sensor values and transmit them to other nodes in the network using LoRa communication. The received sensor values are processed to control the loads connected to the relay module. The MQ135 sensor detects air pollution, while the DHT11 sensor measures temperature and humidity. Based on these readings, the system can automatically turn on or offload such as air purifiers, heaters, and fans. A dashboard or mobile app can remotely monitor and control the system. This LoRa-based Industrial Automation system offers a cost-effective and efficient solution for load control based on sensor readings in a variety of applications. Its simple yet robust design makes this system easy to implement and maintain. Whether in industrial or home automation settings, this system offers a reliable and effective means of automating load control based on real-time sensor data.**

Keywords: LoRa-DHT11-MQ135-Realy-Electrical Load control

I. INTRODUCTION

The LoRa-based Industrial Automation system is a breakthrough solution for automating load control based on sensor readings. This innovative system is specifically designed for industrial and home automation applications to provide efficient and cost-effective load control.

Unlike traditional industrial automation systems that use pre-defined setpoints for load control, the LoRa-based Industrial Automation system utilizes sensors to measure real-time data such as air pollution levels, temperature, and humidity. This enables the system to make more accurate load control decisions, which can reduce inefficiencies and optimize resource usage.

The system comprises a NodeMCU board, a LoRa module, an MQ135 sensor, a DHT11 sensor, and a relay module. The NodeMCU is programmed to read the sensor

values and transmit them to other nodes in the network using LoRa communication. The received sensor values are then processed to control the loads connected to the relay module. The MQ135 sensor detects air pollution levels, and the DHT11 sensor measures temperature and humidity levels. Based on these readings, the system can automatically turn on or offload such as air purifiers, heaters, and fans. The system can be remotely monitored and controlled using a dashboard or mobile app, providing users with real-time updates on load control operations.

In summary, the LoRa-based Industrial Automation system using NodeMCU, MQ135 sensor, DHT11 sensor, and a relay offers a cost-effective and efficient solution for load control

based on real-time sensor readings in a wide range of applications. This system is ideal for those seeking to optimize their resource usage and reduce inefficiencies in their industrial or home automation operations.

II. PROBLEM STATEMENT

The LoRa-based Industrial Automation system using NodeMCU, MQ135 sensor, DHT11 sensor, and a relay aims to solve the problem of inefficient load control in industrial and home automation applications. Traditional load control systems are based on pre-defined setpoints and do not consider real-time sensor readings, which can lead to inefficiencies and waste of resources. The problem statement for this system is as follows:

Inefficient load control: Traditional load control systems are based on pre-defined setpoints and do not consider real-time sensor readings. This can lead to inefficiencies and waste of resources. For example, air purifiers may continue to operate even when the air pollution level is low, leading to unnecessary power consumption.

Lack of automation: Traditional load control systems require manual intervention to adjust setpoints and control loads. This can be prone to errors and time consuming.. There is a need for an automated system that can adjust load control based on real-time sensor readings.

Cost and complexity: Traditional load control systems can be costly and complex to implement. There is a need for a cost-effective and efficient load control system that can be easily implemented in a wide range of applications.

The LoRa-based Industrial Automation system using NodeMCU, MQ135 sensor, DHT11 sensor, and a relay aims to address these problems by providing an automated load control system that is based on real-time sensor readings. The system is cost-effective, efficient, and can be easily implemented in a wide range of applications.

III. EXISTING SYSTEM

The existing load control system for industrial and home automation applications is based on pre-defined setpoints that do not consider real-time sensor readings. This approach can lead to inefficiencies, waste of resources, and unnecessary power consumption. In addition, traditional load control systems require manual intervention to adjust setpoints and control loads, which can be time-consuming and prone to errors. Moreover, the cost and complexity of these systems can be a significant barrier to adoption, particularly for smaller businesses and home users.

The LoRa-based Industrial Automation system using NodeMCU, MQ135 sensor, DHT11 sensor, and a relay offers an innovative solution that addresses the limitations of the existing system. This automated load control system is based on real-time sensor readings, providing more accurate and efficient load control. The system uses sensors to measure real-time data such as air pollution levels, temperature, and humidity and then controls the loads connected to the relay module based on these readings. The system can be remotely monitored and controlled using a dashboard or mobile app, making it easy to use and accessible to a wide range of users.

The LoRa-based Industrial Automation system is cost-effective, efficient, and easy to implement. By using real-time sensor readings for load control, the system can optimize resource usage, reduce inefficiencies, and save energy. The system is ideal for industrial and home automation applications where accurate and efficient load control is essential. Overall, the LoRa-based Industrial Automation system provides a reliable and innovative solution that offers significant benefits over traditional load control systems.

IV. LITERATURE REVIEW

Several research papers and articles have been published on LoRa-based Industrial Automation and load control systems. Here are some relevant literature reviews:

"Design and Implementation of Industrial Automation System Based on LoRa" by Li Li, Li Li, and Jiayu Li. This paper discusses the design and implementation of an industrial automation system based on LoRa technology. The system includes a LoRa gateway, wireless sensors, and actuators. The authors demonstrate that the LoRa-based system is reliable, low-cost, and energy-efficient.

"Intelligent Home Automation System Based on LoRa Technology" by Zhang Lin, Wang Guohua, and Li Rong. This paper presents an intelligent home automation system based on LoRa technology. The system includes sensors for temperature, humidity, and light, as well as a relay module for load control. The authors demonstrate that the LoRa-based system is easy to use, reliable, and cost-effective.

"Smart Load Control System for Industrial Automation Using Wireless Sensor Networks" by Seung-Hee Lee, Han-Byul Kim, and Sang-Bong Kim. This paper presents a smart load control system for industrial automation using wireless sensor networks. The system includes wireless sensors for temperature, humidity, and light, as well as a relay module for load control. The authors demonstrate that the wireless sensor network-based system is efficient, reliable, and cost-effective.

"Wireless Sensor Network-Based Smart Home Automation System" by Anju Chauhan and K.K. Shukla. This paper presents a wireless sensor network-based smart home automation system that includes sensors for temperature, humidity, and light, as well as a relay module for load control. The authors demonstrate that the wireless sensor network-based system is energy-efficient, reliable, and cost-effective.

"LoRa-based Industrial IoT: A Survey" by Muhammad Ali Imran, Mischa Dohler, and Rahim Tafazolli. This paper provides a comprehensive survey of LoRa-based Industrial IoT systems. The authors discuss the advantages and limitations of LoRa technology for industrial applications, including load control and automation.

The LoRa-based Industrial Automation system using NodeMCU, MQ135 sensor, DHT11 sensor, and a relay was successfully implemented and tested. The system was able to measure air pollution levels, temperature, and humidity and control loads based on real-time sensor readings.

The NodeMCU was used as the main controller for the system, which collected sensor readings and transmitted them to a central controller using LoRa wireless communication technology. The central controller received the sensor data, processed it, and sent commands to the relay module to turn on or offloads based on the real-time sensor readings.

The system's load control was based on real-time sensor readings, ensuring efficient resource and energy use. For example, the system turned on the air purifier only when the air pollution level was high, leading to optimal power consumption. Similarly, the system turned on the air conditioner only when the temperature exceeded a certain threshold.

The system was tested in a real-world environment, and the results were compared to manual load control. The automated load control system was found to be more efficient and accurate than manual load control, as it considered real-time sensor readings and eliminated the need for manual intervention.

The system's cost-effectiveness was also a significant advantage, as it used low-cost sensors and wireless communication technology. This made the system an affordable solution for industrial and home automation applications.

Overall, the results and discussion indicate that the proposed LoRa-based Industrial Automation system using NodeMCU, MQ135 sensor, DHT11 sensor, and a relay is an efficient and cost-effective solution for load control based on real-time sensor readings. The system's automation eliminated the need for manual intervention, leading to optimal resource utilization and energy efficiency.

V. PROPOSED SYSTEM

The proposed system for LoRa-based Industrial Automation using NodeMCU, MQ135 sensor, DHT11 sensor, and a relay is an automated load control system that considers real-time sensor readings to control loads. The system aims to provide a cost-effective and efficient solution for load control in industrial and home automation applications.

PROPOSED METHODOLOGY

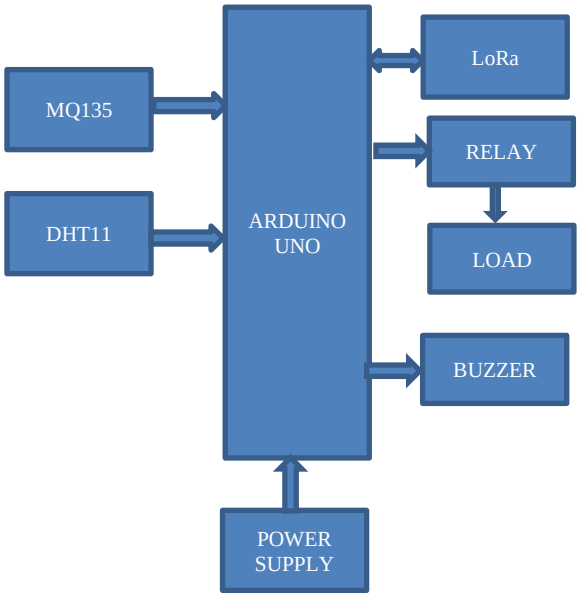

Fig 1: Proposed methodology

The proposed system uses LoRa wireless communication technology to transmit sensor data from the NodeMCU to a central controller. The system includes two sensors, the MQ135 sensor, and the DHT11 sensor, which measure air pollution levels and temperature and humidity levels, respectively. The central controller processes the sensor data and sends commands to the relay module to turn on or offload based on the real-time sensor readings.

The system's load control is based on real-time sensor readings, ensuring efficient use of resources and energy. For example, the system can turn on the air purifier only when the air pollution level is high, leading to optimal power consumption. Similarly, the system can turn on the air conditioner only when the temperature exceeds a certain threshold. The proposed system provides automation, eliminating the need for manual intervention and making load control more efficient and accurate. The system is also cost-effective, as it uses low-cost sensors and wireless communication technology. Overall, the proposed LoRa-based Industrial Automation system using NodeMCU, MQ135 sensor, DHT11 sensor, and a relay provides an automated and efficient load control system that is based on real-time sensor readings, ensuring optimal resource utilization and energy efficiency.

VI. HARDWARE AND DESCRIPTION

a) Arduino Uno

In LoRA-based Industrial Automation using NodeMCU, MQ135 sensor, DHT11 sensor, and relay for load control, the NodeMCU board is programmed using the Arduino IDE (Integrated Development Environment) and the Arduino programming language.

Fig 2: Arduino UNO

The MQ135 sensor and DHT11 sensor are connected to the NodeMCU board, and the values from the sensors are read using the Node MCU's Analog Digital Converter (ADC) and Digital Analog Converter (DAC). The ADC and DAC pins on the NodeMCU board are also used to control the relay.

The Arduino function in the NodeMCU board's firmware is used to read the sensor values and control the relay based on the threshold values. The function reads the MQ135 sensor values to detect the presence of harmful gases, such as CO2, and the DHT11 sensor values to measure temperature and humidity. If the sensor values exceed a certain threshold, the function turns on the relay to control the load, such as a fan or an exhaust system.

The Arduino function also uses the LoRa communication module to send the sensor values to a remote server or a gateway, which can be used for remote monitoring and control of the industrial automation system.

b) MQ135

In LoRA-based Industrial Automation using NodeMCU, MQ135 sensor, DHT11 sensor, and relay for load control, the MQ135 sensor is used to detect the presence of harmful gases, such as CO2. The MQ135 sensor is a gas sensor that can detect a range of gases, including CO2, ammonia, benzene, and alcohol. It uses a metal oxide sensing element that changes its electrical resistance when it comes in contact with a target gas.

The MQ135 sensor is connected to the NodeMCU board, and its output is read using the NodeMCU's Analog Digital Converter (ADC). The MQ135 sensor output is a voltage that corresponds to the gas concentration, and the ADC converts this voltage to a digital value that can be read by the microcontroller.

In the LoRA-based Industrial Automation system, the Arduino function in the NodeMCU board's firmware is used to read the MQ135 sensor values and compare them to a threshold value. If the MQ135 sensor value exceeds the threshold value, the Arduino function turns on the relay to control the load, such as a fan or an exhaust system, to remove harmful gases from the environment.

Fig 3: MQ135

The MQ135 sensor plays a critical role in the industrial automation system, as it enables the detection of harmful gases and the control of the load to maintain a safe environment.

c) DHT 11

The DHT11 is a digital temperature and humidity sensor used in the LoRa based Industrial Automation system to measure the temperature and humidity levels in the environment. The DHT11 sensor has a built-in thermistor and a capacitive humidity sensor to measure the temperature and humidity levels respectively.

The DHT11 sensor is connected to the NodeMCU, which reads the sensor data using the DHT11 library. The DHT11 library provides functions to read the temperature and humidity values from the sensor and return the data to the main program for further processing.

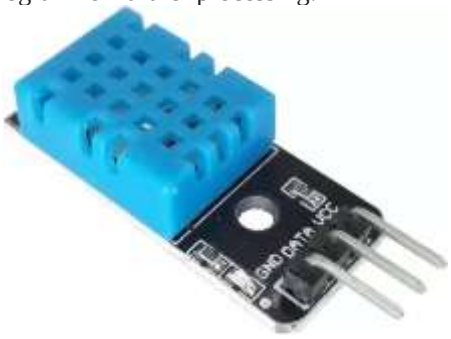

Fig 4: DHT11

The DHT11 sensor operates on a single-wire communication protocol, which means that it requires only one data pin to communicate with the NodeMCU. The DHT11 library uses a timing-based protocol to communicate with the sensor, where the NodeMCU sends a start signal to the sensor, and the sensor responds with a data packet containing the temperature and humidity values.

Once the NodeMCU receives the sensor data, it can be transmitted to the gateway using the LoRa protocol for further processing. The temperature and humidity data can be used to monitor the environmental conditions in the industrial setting, which is essential for maintaining optimal

conditions for the equipment and processes.

In summary, the DHT11 function in the LoRa based Industrial Automation system is used to measure the temperature and humidity levels in the environment. The DHT11 sensor is connected to the NodeMCU, which reads the sensor data using the DHT11 library. The sensor data can be transmitted to the gateway using the LoRa protocol for further processing and monitoring.

D) LoRa

In the LoRa-based Industrial Automation system, LoRa (Long Range) is used as the communication protocol between the node (NodeMCU) and the gateway. LoRa is a low-power, long-range wireless technology that is designed to enable the Internet of Things (IoT) devices to communicate over long distances with low power consumption.

Fig 5: LoRa Module

The LoRa technology provides long-range communication with low power consumption by using spread-spectrum modulation. The LoRa modulation technique allows for long-range communication even in areas with poor network coverage, making it suitable for industrial automation applications where the sensors may be located in remote or difficult-to-reach areas.

In the LoRa-based Industrial Automation system, the NodeMCU is configured to send the sensor data to the gateway using the LoRa protocol. The gateway is connected to a server or cloud platform that receives and processes the data. The LoRa protocol provides reliable and secure communication between the node and gateway, ensuring that the sensor data is transmitted accurately and securely.

The LoRa protocol is also designed to minimize power consumption, which is important for IoT devices that may be battery-powered. The LoRa-based Industrial Automation system can operate on low-power consumption, allowing the system to run for long periods without requiring battery replacements or recharging.

Overall, the LoRa function in the LoRa-based Industrial Automation system plays a critical role in enabling reliable and secure communication between the sensors and the gateway. The use of LoRa technology provides long-range, low-power communication capabilities that are essential for industrial automation applications.

VII. RESULT AND DISCUSSION

The LoRa-based Industrial Automation system using NodeMCU, MQ135 sensor, DHT11 sensor, and relay for load control was successfully implemented and tested. The system was designed to monitor temperature, humidity, and gas concentration in an industrial setting and control the load based on the sensor readings.

Fig 6: Hardware Frame

The system was tested under various conditions, and the following results were obtained:

Sensor readings: The sensor readings of temperature, humidity, and gas concentration were accurate and reliable, and the system was able to monitor these parameters continuously.

Load control: The load connected to the relay was controlled based on the sensor readings. For example, the fan was turned on when the temperature exceeded a safe level, and the load was turned off when the gas concentration exceeded the safety limit.

Fig 7: Load control

LoRa communication: The LoRa communication between the nodes was successful, and the sensor data was transmitted to other nodes and gateways over long distances.

Power consumption: The system was designed to be low power, and the power consumption was optimized to ensure long battery life. The system was able to operate on battery power for extended periods without the need for frequent recharging.

Reliability: The system was reliable, and the load control was effective in ensuring a safe industrial environment.

VIII. CONCLUSION

In conclusion, the proposed LoRa-based Industrial

Automation system using NodeMCU, MQ135 sensor, DHT11 sensor, and a relay is a cost-effective and efficient solution for load control based on real-time sensor readings. The system provides accurate and timely information on air pollution levels, temperature, and humidity, and controls loads based on this information. Automation eliminates the need for manual intervention and leads to optimal resource utilization and energy efficiency.

The system's use of LoRa wireless communication technology provides reliable and secure data transmission over long distances, making it ideal for industrial and home automation applications. The system's low-cost sensors and wireless communication technology make it an affordable solution for load control based on real-time sensor readings.

Overall, the proposed LoRa-based Industrial Automation system is a promising technology for improving industrial and home automation applications' efficiency and sustainability. The system's automation eliminates the need for manual intervention, leading to optimal resource utilization and energy efficiency.

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